FIG.1

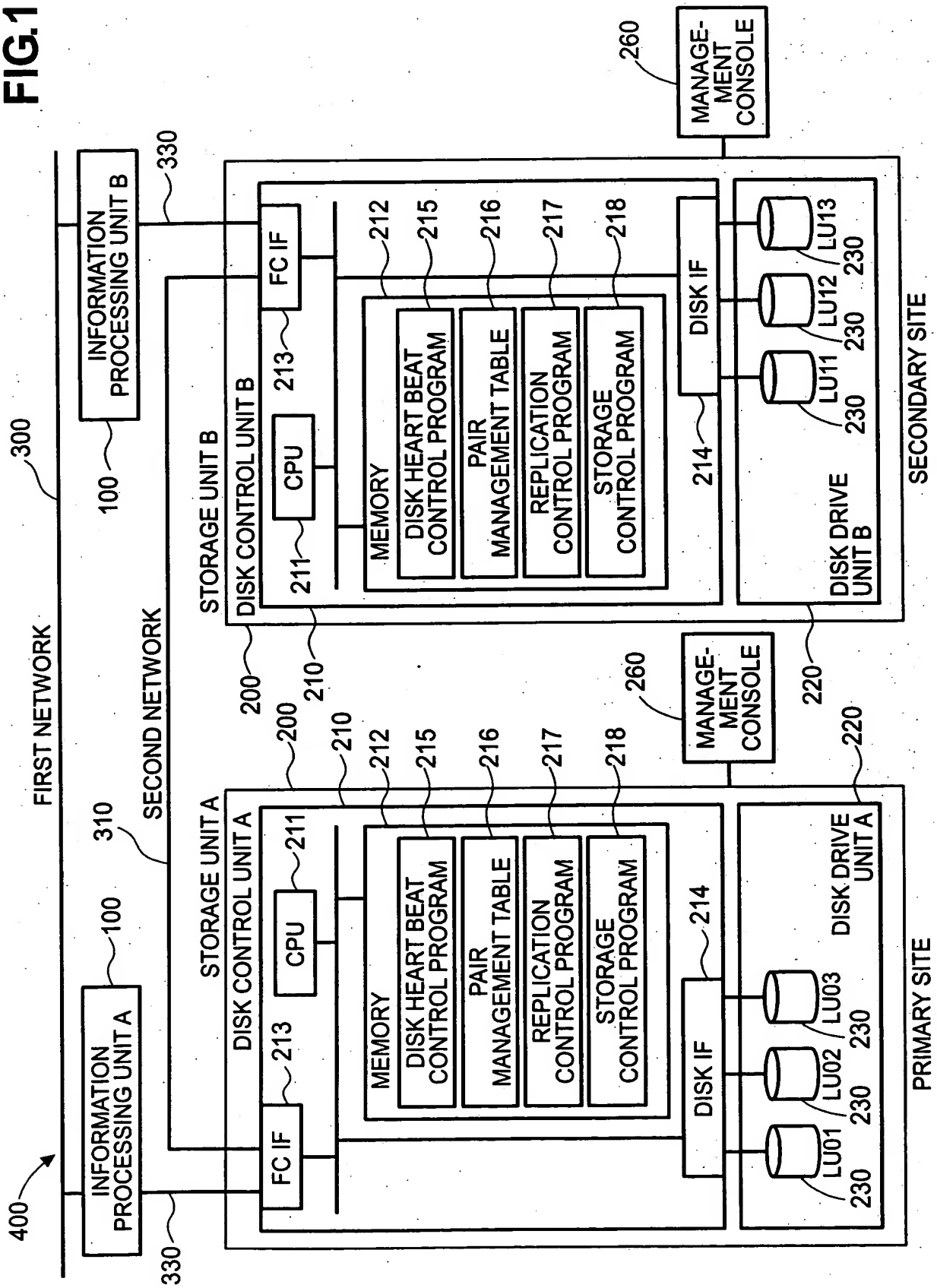
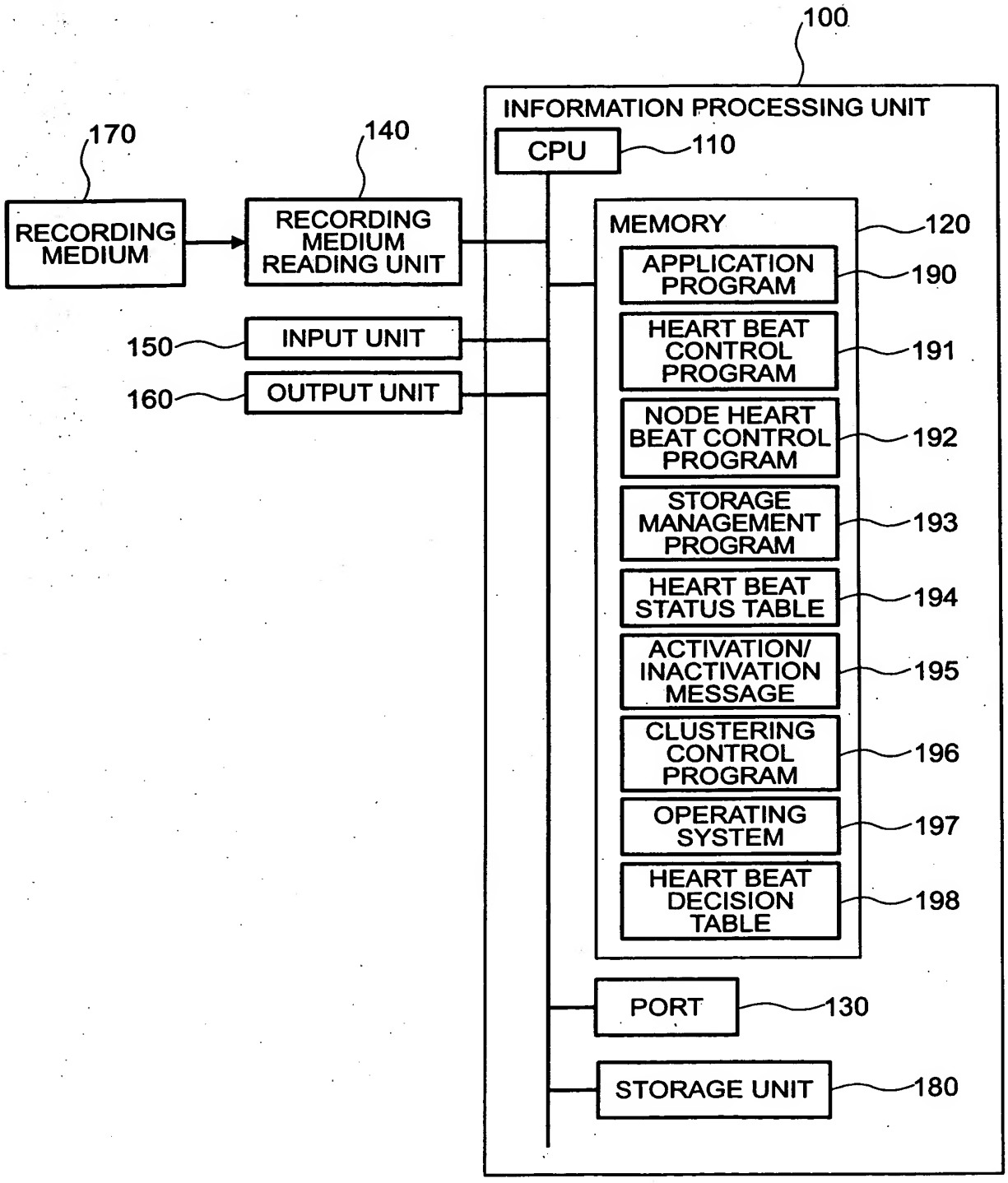

400
FIRST NETWORK
SECOND NETWORK
INFORMATION PROCESSING UNIT A
INFORMATION PROCESSING UNIT B
100
300
310
330
STORAGE UNIT A
STORAGE UNIT B
DISK CONTROL UNIT A
DISK CONTROL UNIT B
FC IF
CPU
MEMORY
DISK HEART BEAT CONTROL PROGRAM
PAIR MANAGEMENT TABLE
REPLICATION CONTROL PROGRAM
STORAGE CONTROL PROGRAM
DISK IF
DISK DRIVE UNIT A
DISK DRIVE UNIT B
PRIMARY SITE
SECONDARY SITE
MANAGE-MENT CONSOLE
200
210
211
212
213
214
215
216
217
218
220
230
260
LU01
LU02
LU03
LU11
LU12
LU13

FIG.2


100
INFORMATION PROCESSING UNIT
CPU
110
MEMORY
120
APPLICATION PROGRAM
190
HEART BEAT CONTROL PROGRAM
191
NODE HEART BEAT CONTROL PROGRAM
192
STORAGE MANAGEMENT PROGRAM
193
HEART BEAT STATUS TABLE
194
ACTIVATION/ INACTIVATION MESSAGE
195
CLUSTERING CONTROL PROGRAM
196
OPERATING SYSTEM
197
HEART BEAT DECISION TABLE
198
PORT
130
STORAGE UNIT
180
170
RECORDING MEDIUM
140
RECORDING MEDIUM READING UNIT
150
INPUT UNIT
160
OUTPUT UNIT

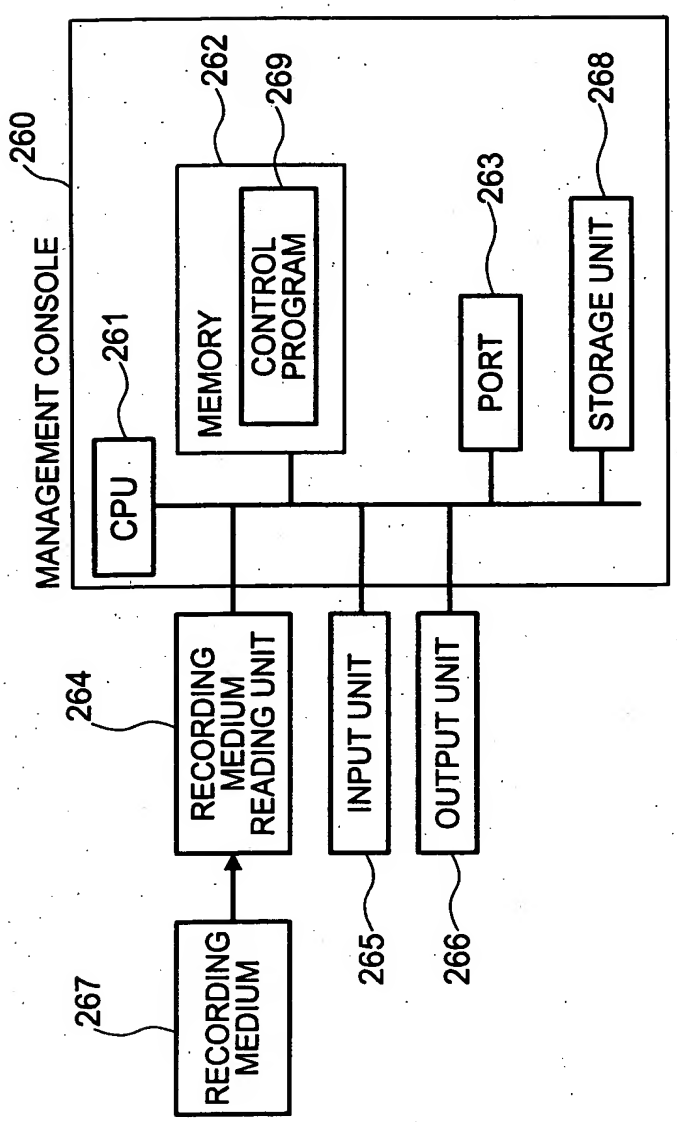


FIG.3

PAIR MANAGEMENT TABLE 216

PAIR TYPE	REPRO-DUCTION TYPE	REPRO-DUCTION SOURCE UNIT	REPRO-DUCTION DESTINATION UNIT	REPRO-DUCTION SOURCE VOLUME	REPRO-DUCTION DESTINATION VOLUME	PAIR STATUS
REMOTE	SYNCHRO-NOUS	A	B	2	2	SPLIT
REMOTE	SYNCHRO-NOUS	A	B	1	3	PAIR
REMOTE	SYNCHRO-NOUS	A	B	0	0	PAIR
...	...	...	...	...	...	...

FIG.4

FIG.5

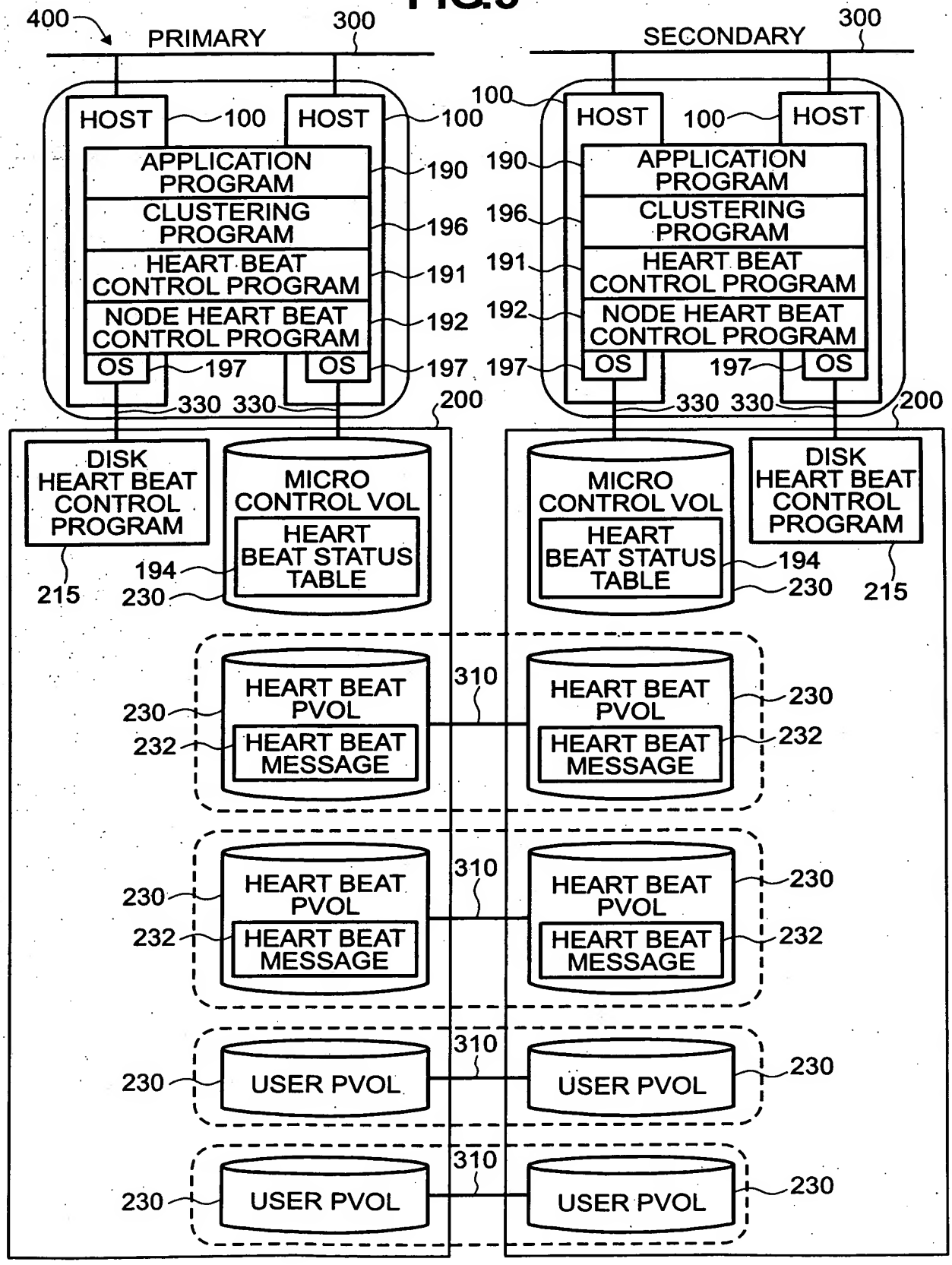

400
PRIMARY
300
SECONDARY
300
HOST
100
HOST
100
100
HOST
100
HOST
APPLICATION PROGRAM
190
CLUSTERING PROGRAM
196
HEART BEAT CONTROL PROGRAM
191
NODE HEART BEAT CONTROL PROGRAM
192
OS
197
OS
197
190
196
191
192
197
OS
197
OS
330 330
200
330 330
200
DISK HEART BEAT CONTROL PROGRAM
215
MICRO CONTROL VOL
HEART BEAT STATUS TABLE
194
230
MICRO CONTROL VOL
HEART BEAT STATUS TABLE
194
230
DISK HEART BEAT CONTROL PROGRAM
215
HEART BEAT PVOL
HEART BEAT MESSAGE
230
232
310
HEART BEAT PVOL
HEART BEAT MESSAGE
230
232
HEART BEAT PVOL
HEART BEAT MESSAGE
230
232
310
HEART BEAT PVOL
HEART BEAT MESSAGE
230
232
USER PVOL
230
310
USER PVOL
230
USER PVOL
230
310
USER PVOL
230

FIG.6

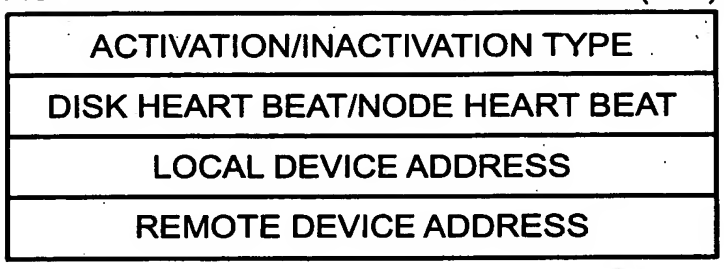

ACTIVATION/INACTIVATION MESSAGE (195)
ACTIVATION/INACTIVATION TYPE
DISK HEART BEAT/NODE HEART BEAT
LOCAL DEVICE ADDRESS
REMOTE DEVICE ADDRESS

FIG.7

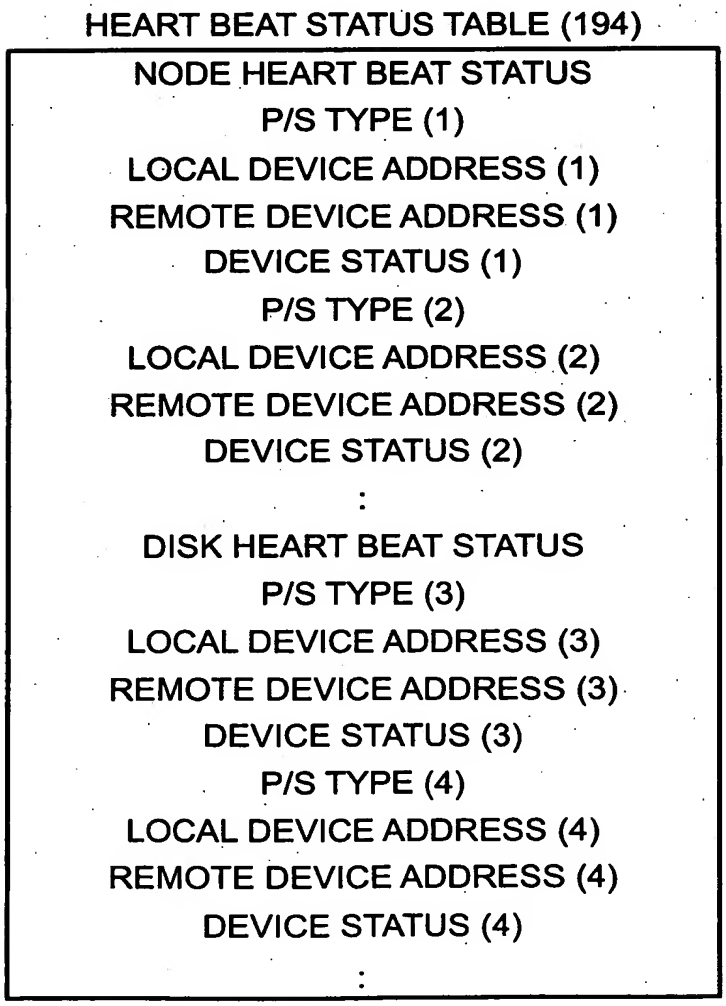

HEART BEAT STATUS TABLE (194)
NODE HEART BEAT STATUS
P/S TYPE (1)
LOCAL DEVICE ADDRESS (1)
REMOTE DEVICE ADDRESS (1)
DEVICE STATUS (1)
P/S TYPE (2)
LOCAL DEVICE ADDRESS (2)
REMOTE DEVICE ADDRESS (2)
DEVICE STATUS (2)
:
DISK HEART BEAT STATUS
P/S TYPE (3)
LOCAL DEVICE ADDRESS (3)
REMOTE DEVICE ADDRESS (3)
DEVICE STATUS (3)
P/S TYPE (4)
LOCAL DEVICE ADDRESS (4)
REMOTE DEVICE ADDRESS (4)
DEVICE STATUS (4)
:

FIG.8

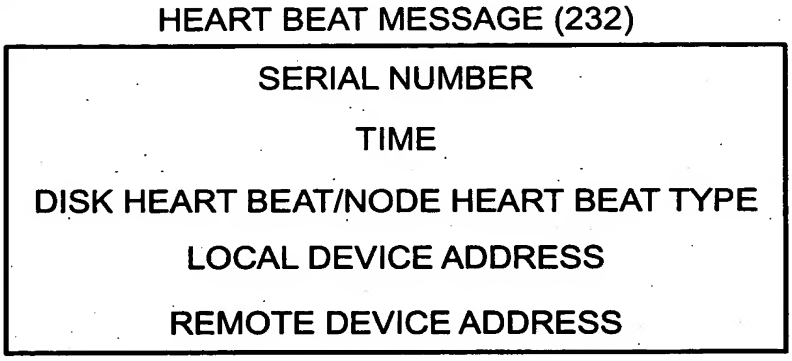

HEART BEAT MESSAGE (232)
SERIAL NUMBER
TIME
DISK HEART BEAT/NODE HEART BEAT TYPE
LOCAL DEVICE ADDRESS
REMOTE DEVICE ADDRESS

FIG.9

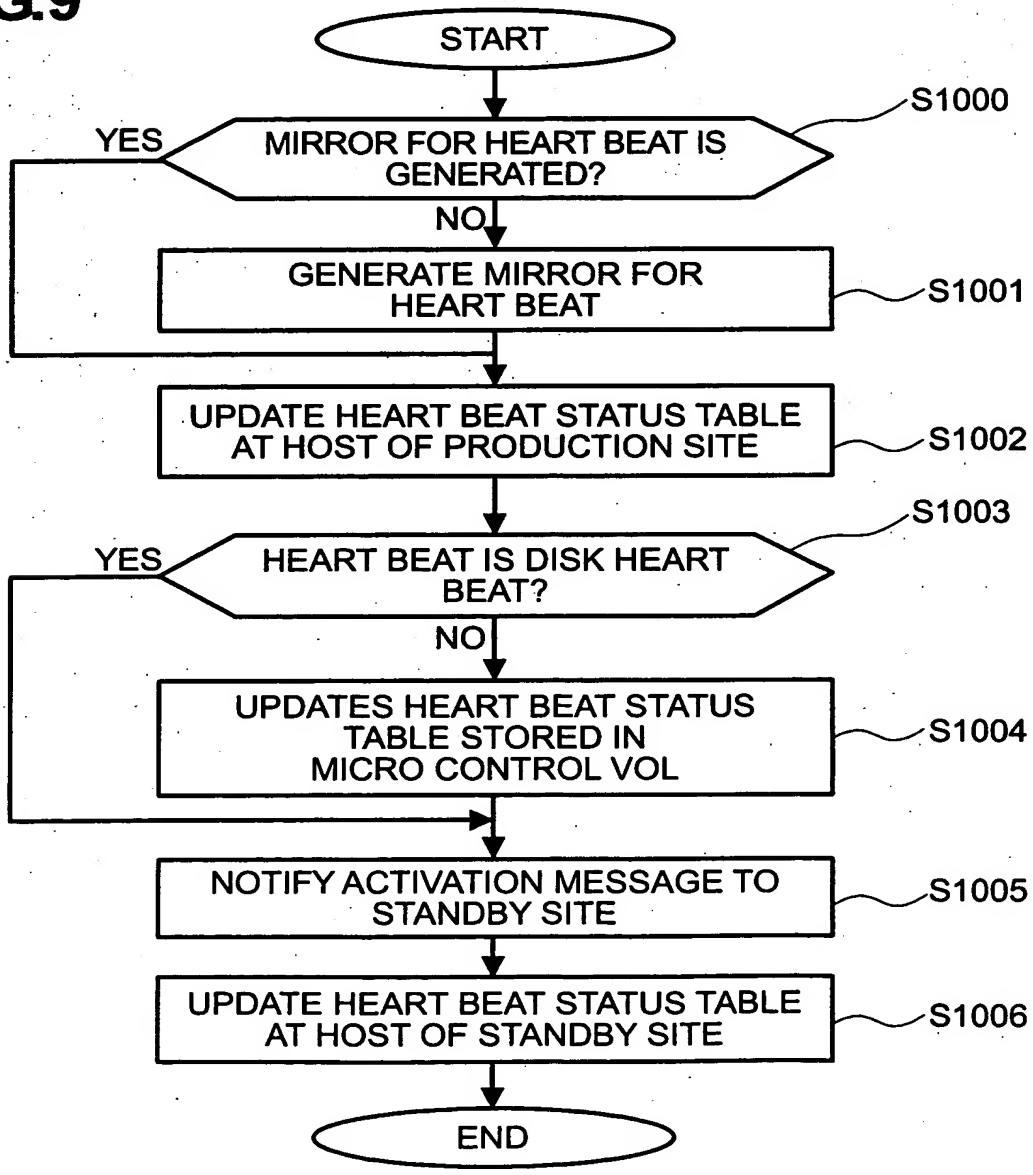

START
S1000
YES
MIRROR FOR HEART BEAT IS GENERATED?
NO
GENERATE MIRROR FOR HEART BEAT
S1001
UPDATE HEART BEAT STATUS TABLE AT HOST OF PRODUCTION SITE
S1002
S1003
YES
HEART BEAT IS DISK HEART BEAT?
NO
UPDATES HEART BEAT STATUS TABLE STORED IN MICRO CONTROL VOL
S1004
NOTIFY ACTIVATION MESSAGE TO STANDBY SITE
S1005
UPDATE HEART BEAT STATUS TABLE AT HOST OF STANDBY SITE
S1006
END

FIG.10

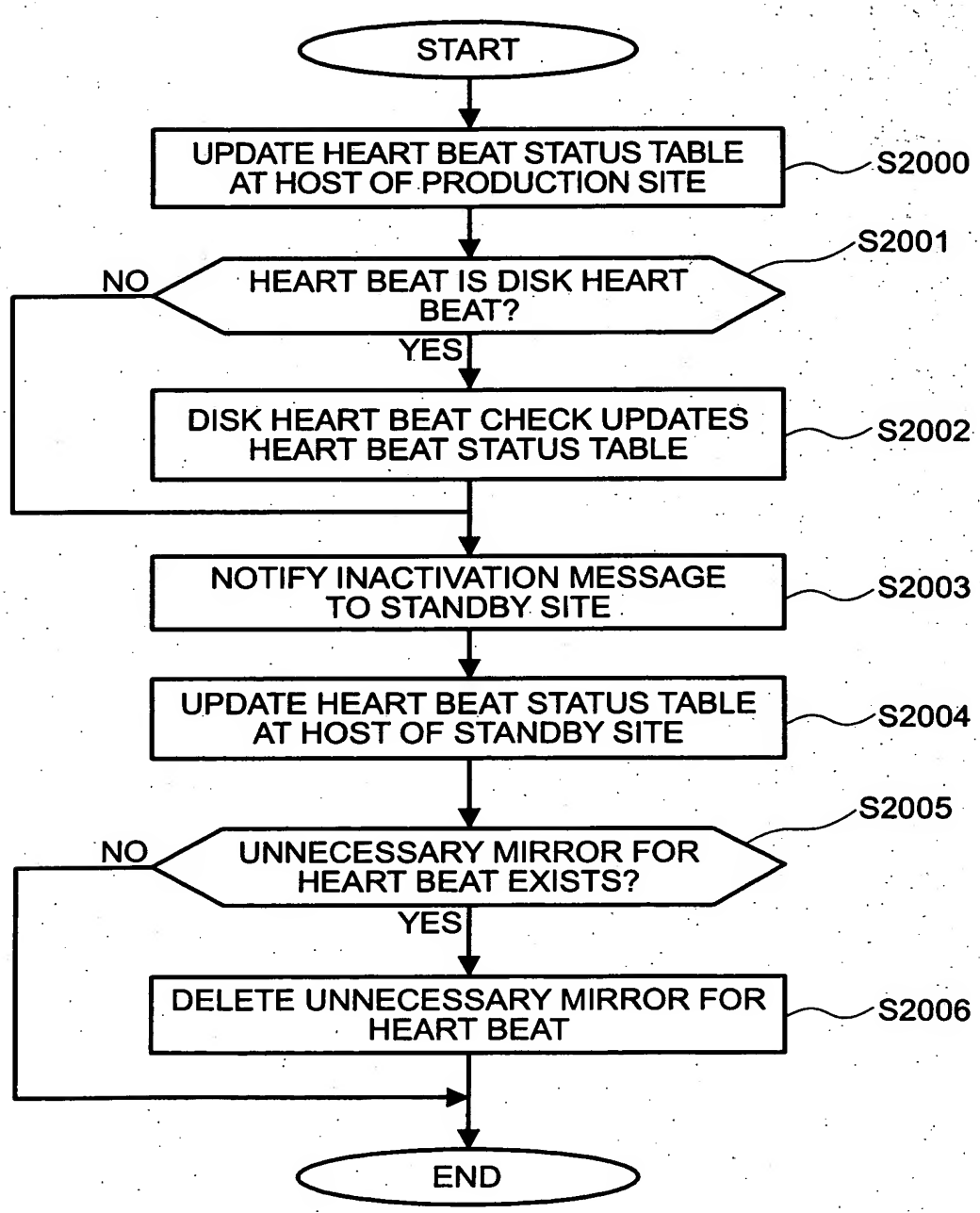

START
UPDATE HEART BEAT STATUS TABLE AT HOST OF PRODUCTION SITE
S2000
S2001
NO
HEART BEAT IS DISK HEART BEAT?
YES
DISK HEART BEAT CHECK UPDATES HEART BEAT STATUS TABLE
S2002
NOTIFY INACTIVATION MESSAGE TO STANDBY SITE
S2003
UPDATE HEART BEAT STATUS TABLE AT HOST OF STANDBY SITE
S2004
S2005
NO
UNNECESSARY MIRROR FOR HEART BEAT EXISTS?
YES
DELETE UNNECESSARY MIRROR FOR HEART BEAT
S2006
END

FIG.11

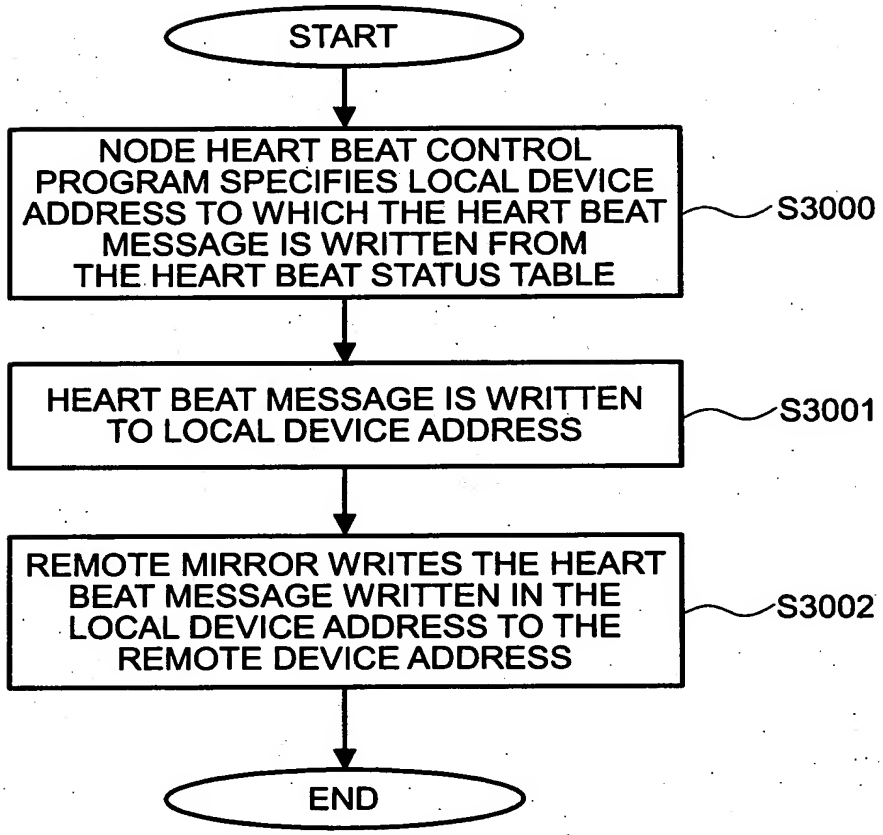

START
NODE HEART BEAT CONTROL PROGRAM SPECIFIES LOCAL DEVICE ADDRESS TO WHICH THE HEART BEAT MESSAGE IS WRITTEN FROM THE HEART BEAT STATUS TABLE
S3000
HEART BEAT MESSAGE IS WRITTEN TO LOCAL DEVICE ADDRESS
S3001
REMOTE MIRROR WRITES THE HEART BEAT MESSAGE WRITTEN IN THE LOCAL DEVICE ADDRESS TO THE REMOTE DEVICE ADDRESS
S3002
END

FIG.12

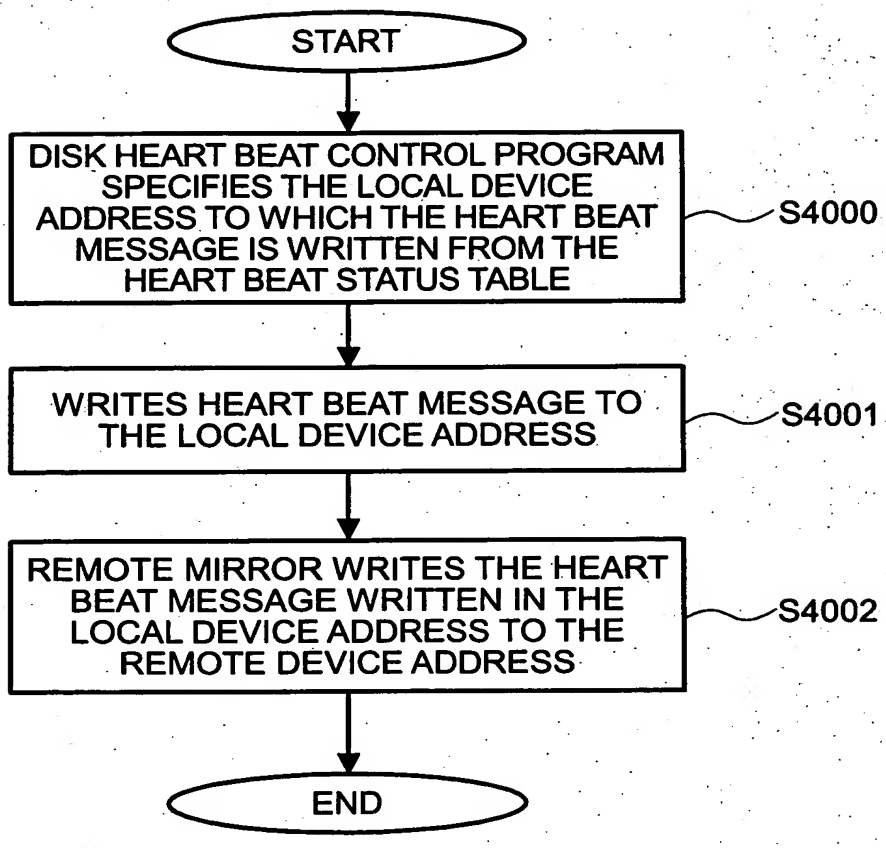

START
DISK HEART BEAT CONTROL PROGRAM SPECIFIES THE LOCAL DEVICE ADDRESS TO WHICH THE HEART BEAT MESSAGE IS WRITTEN FROM THE HEART BEAT STATUS TABLE
S4000
WRITES HEART BEAT MESSAGE TO THE LOCAL DEVICE ADDRESS
S4001
REMOTE MIRROR WRITES THE HEART BEAT MESSAGE WRITTEN IN THE LOCAL DEVICE ADDRESS TO THE REMOTE DEVICE ADDRESS
S4002
END

FIG.13

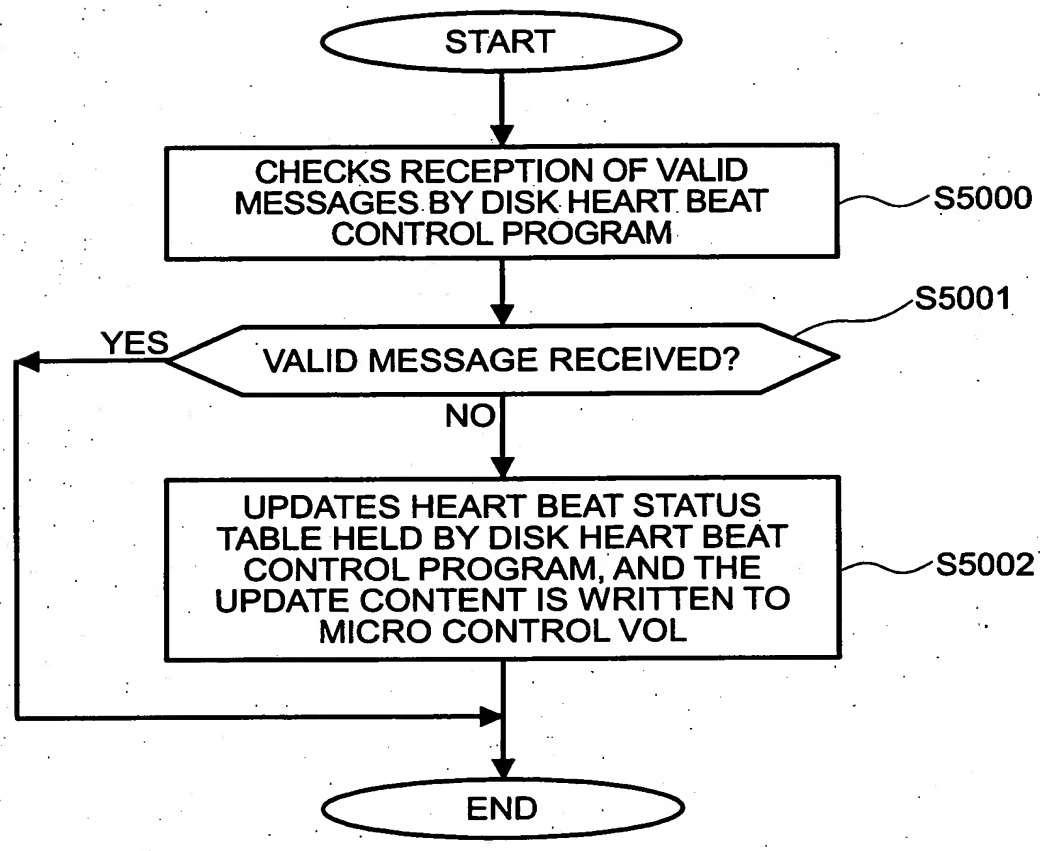

START
CHECKS RECEPTION OF VALID MESSAGES BY DISK HEART BEAT CONTROL PROGRAM
S5000
S5001
YES
VALID MESSAGE RECEIVED?
NO
UPDATES HEART BEAT STATUS TABLE HELD BY DISK HEART BEAT CONTROL PROGRAM, AND THE UPDATE CONTENT IS WRITTEN TO MICRO CONTROL VOL
S5002
END

FIG.14

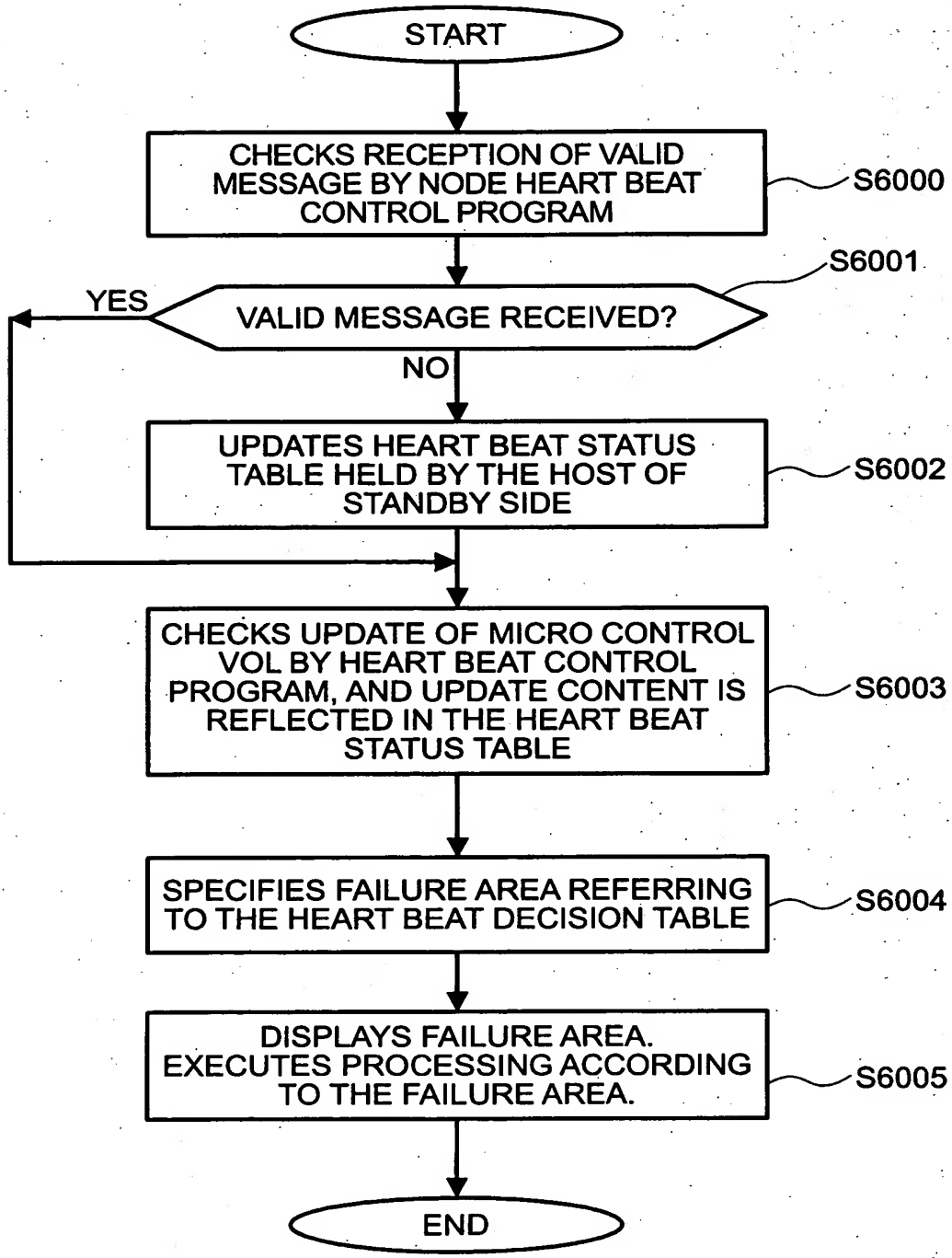

START
CHECKS RECEPTION OF VALID MESSAGE BY NODE HEART BEAT CONTROL PROGRAM
S6000
S6001
YES
VALID MESSAGE RECEIVED?
NO
UPDATES HEART BEAT STATUS TABLE HELD BY THE HOST OF STANDBY SIDE
S6002
CHECKS UPDATE OF MICRO CONTROL VOL BY HEART BEAT CONTROL PROGRAM, AND UPDATE CONTENT IS REFLECTED IN THE HEART BEAT STATUS TABLE
S6003
SPECIFIES FAILURE AREA REFERRING TO THE HEART BEAT DECISION TABLE
S6004
DISPLAYS FAILURE AREA. EXECUTES PROCESSING ACCORDING TO THE FAILURE AREA.
S6005
END

FIG.15

198

		NODE HEART BEAT SIGNAL	
		OK	NG
DISK HEART BEAT SIGNAL	OK	①	②
	NG	③	④

FIG.16

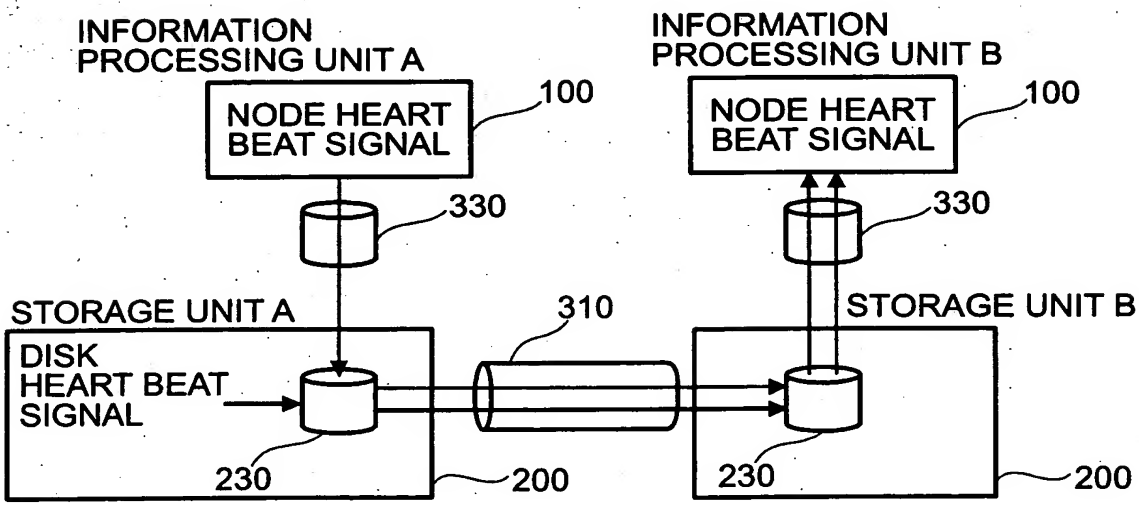


FIG.17

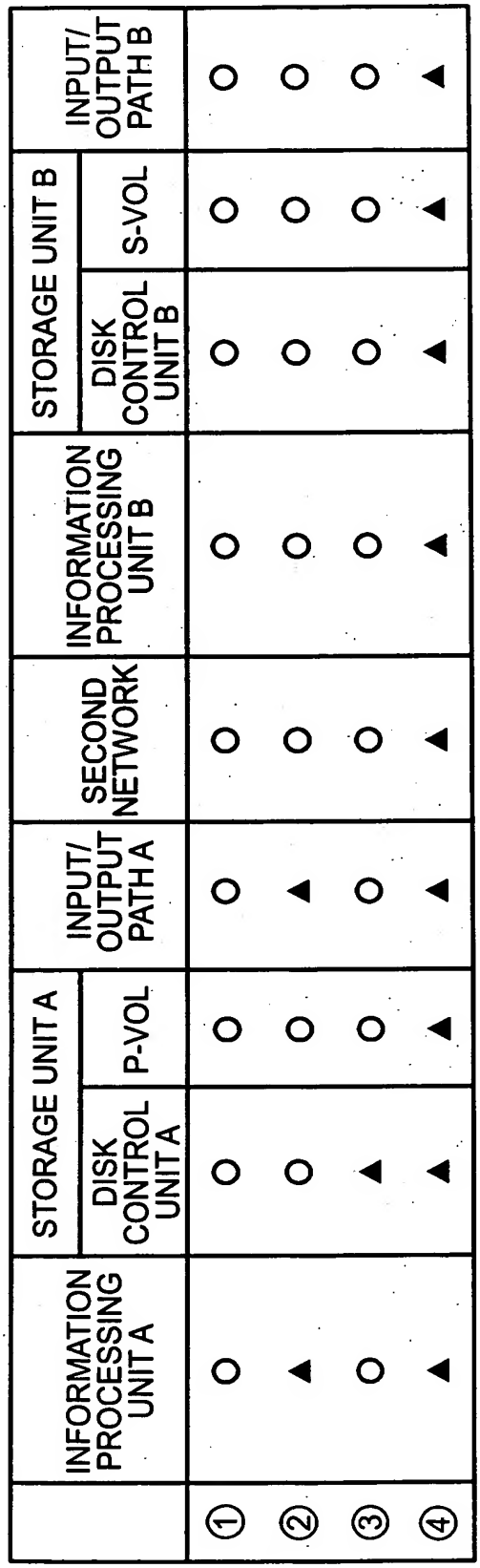

INFORMATION PROCESSING UNIT A
STORAGE UNIT A
DISK CONTROL UNIT A
P-VOL
INPUT/ OUTPUT PATH A
SECOND NETWORK
INFORMATION PROCESSING UNIT B
STORAGE UNIT B
DISK CONTROL UNIT B
S-VOL
INPUT/ OUTPUT PATH B
①
②
③
④

FIG.18

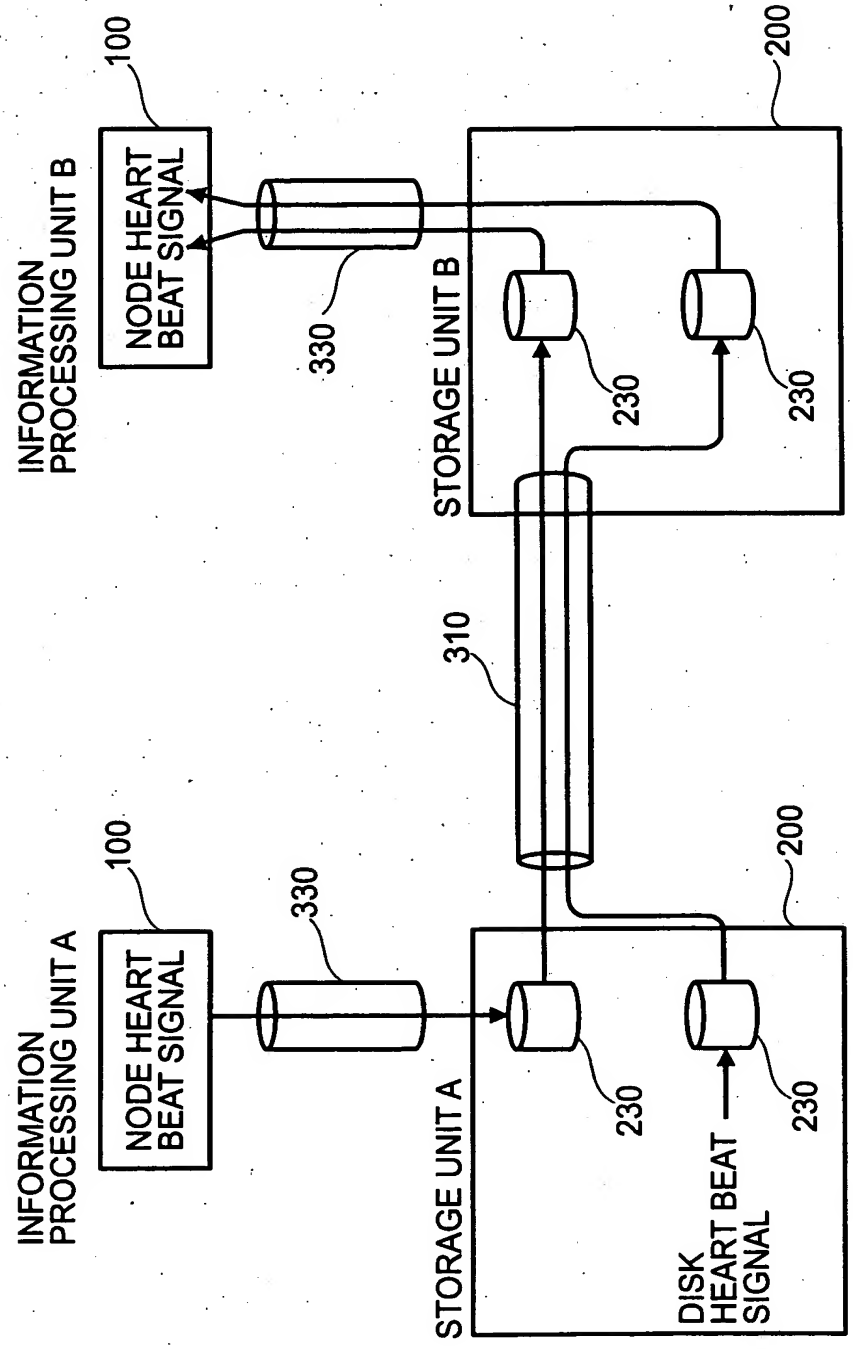

100
200
INFORMATION PROCESSING UNIT B
NODE HEART BEAT SIGNAL
330
STORAGE UNIT B
230
230
310
100
200
330
INFORMATION PROCESSING UNIT A
NODE HEART BEAT SIGNAL
STORAGE UNIT A
230
230
DISK HEART BEAT SIGNAL

FIG.19

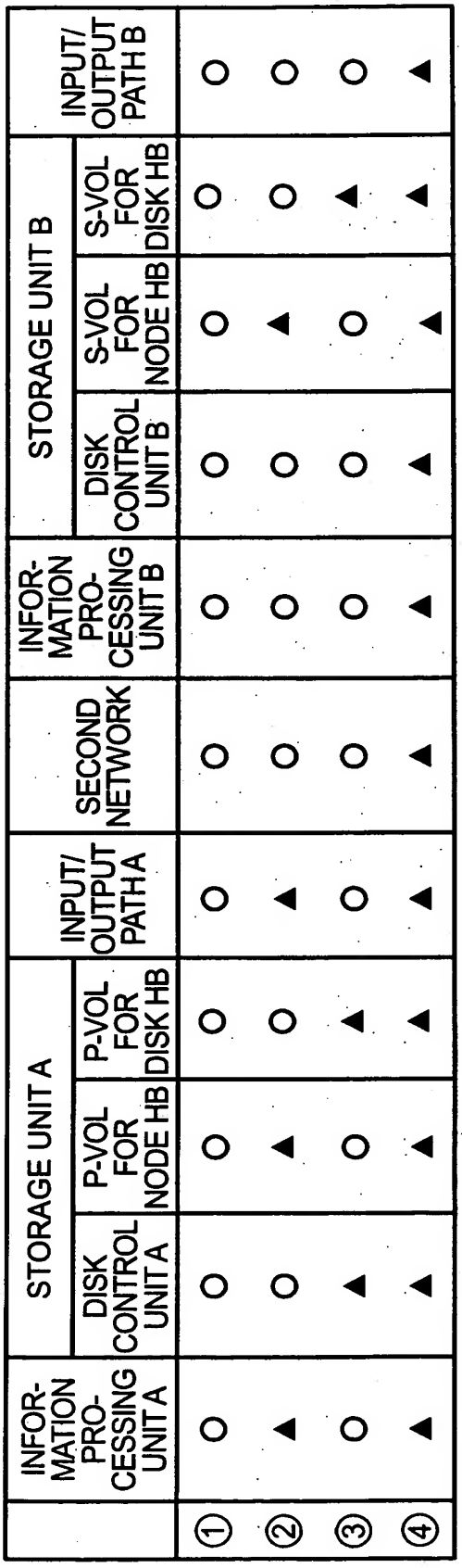

INFOR-MATION PRO-CESSING UNIT A
STORAGE UNIT A
DISK CONTROL UNIT A
P-VOL FOR NODE HB
P-VOL FOR DISK HB
INPUT/ OUTPUT PATH A
SECOND NETWORK
INFOR-MATION PRO-CESSING UNIT B
STORAGE UNIT B
DISK CONTROL UNIT B
S-VOL FOR NODE HB
S-VOL FOR DISK HB
INPUT/ OUTPUT PATH B
①
②
③
④

FIG.20

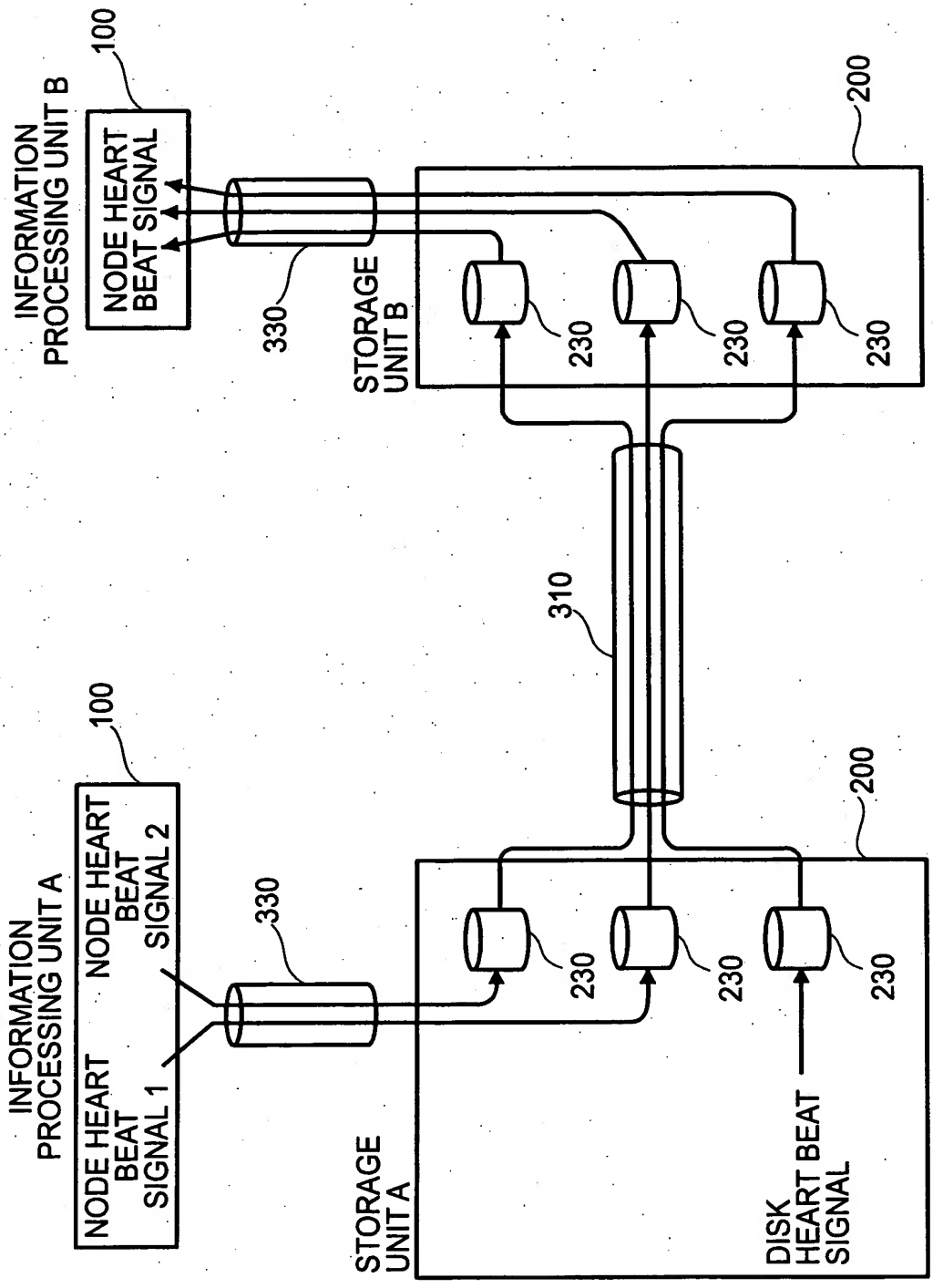

INFORMATION PROCESSING UNIT B
100
NODE HEART BEAT SIGNAL
330
STORAGE UNIT B
200
230
230
230
310
INFORMATION PROCESSING UNIT A
100
NODE HEART BEAT SIGNAL 2
NODE HEART BEAT SIGNAL 1
330
STORAGE UNIT A
200
230
230
230
DISK HEART BEAT SIGNAL

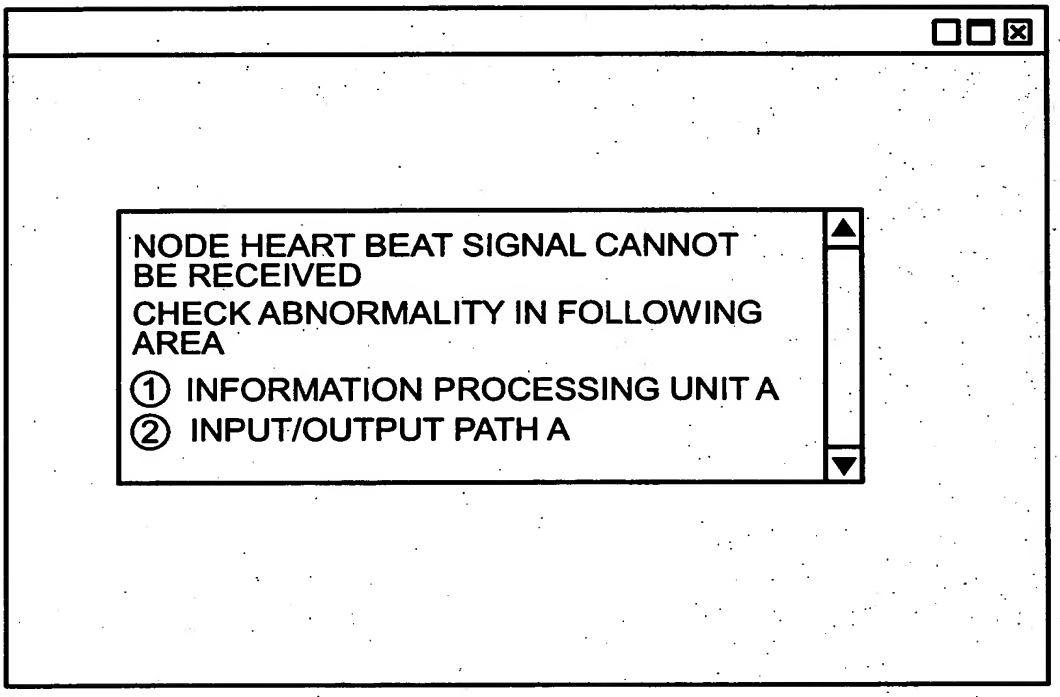
FIG.21

		NODE HEART BEAT SIGNAL 1			
		OK		NG	
		NODE HEART BEAT SIGNAL 2		NODE HEART BEAT SIGNAL 2	
		OK	NG	OK	NG
DISK HEART BEAT SIGNAL	OK	①	②	③	④
	NG	⑤	⑥	⑦	⑧

FIG.22

	INFORMATION PROCESSING UNIT A	STORAGE UNIT A				INPUT/OUTPUT PATH A	SECOND NETWORK	INFORMATION PROCESSING UNIT B	STORAGE UNIT B				INPUT/OUTPUT PATH B
		DISK CONTROL UNIT A	P-VOL 1 FOR NODE HB	P-VOL 2 FOR NODE HB	P-VOL FOR DISK HB				DISK CONTROL UNIT B	S-VOL 1 FOR NODE HB	S-VOL 2 FOR NODE HB	S-VOL FOR DISK HB	
①	○	○	○	○	○	○	○	○	○	○	○	○	○
②	○	○	○	◀	○	○	○	○	○	○	◀	○	○
③	○	○	◀	○	○	○	○	○	○	◀	○	○	○
④	◀	○	◀	◀	○	◀	○	○	○	◀	◀	○	○
⑤	○	○	○	○	◀	○	○	○	○	○	○	◀	○
⑥	○	○	○	◀	◀	○	○	○	○	○	◀	◀	○
⑦	○	○	◀	○	◀	○	○	○	○	◀	○	◀	○
⑧	◀	◀	◀	◀	◀	◀	◀	◀	◀	◀	◀	◀	◀

FIG.23


NODE HEART BEAT SIGNAL CANNOT BE RECEIVED
CHECK ABNORMALITY IN FOLLOWING AREA
① INFORMATION PROCESSING UNIT A
② INPUT/OUTPUT PATH A